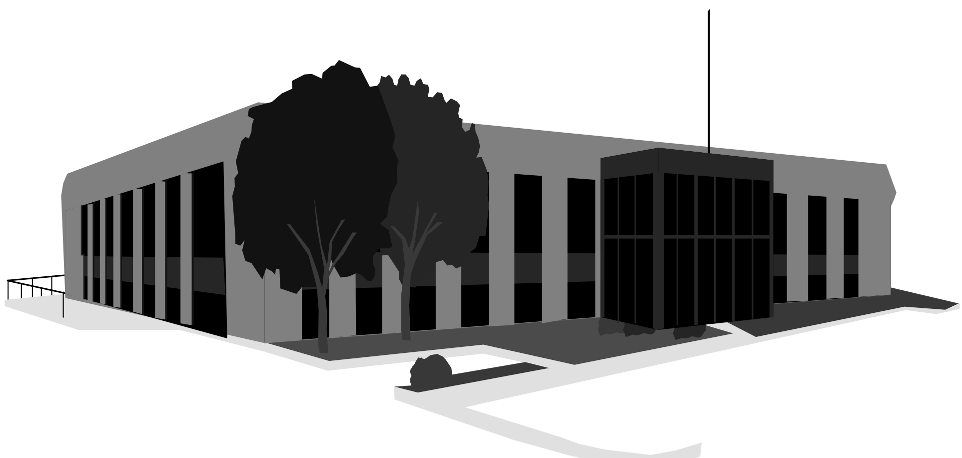
INDOOR AIR QUALITY ASSESSMENT

McDonough City Magnet School
43 French Street
Lowell, Massachusetts



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of the Lowell Health Department, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) was asked to provide assistance and consultation regarding indoor air quality issues and health concerns at the McDonough City Magnet School in Lowell, Massachusetts.

On November 21, 2000 Cory Holmes, Environmental Analyst of the Emergency Response/Indoor Air Quality (ER/IAQ) Program and Suzan Donahue, Research Assistant, BEHA conducted an indoor air quality assessment. John Wolfgang, Head Custodian, accompanied BEHA staff for portions of the assessment.

The McDonough Magnet complex is a three-story brick building that contains both the "Arts" and "City" schools, which are connected by a common hallway. The building was originally constructed in the late 1800's as a trade school. In the 1930's an addition was built that currently houses the "City" school. Between 1985-1987 the McDonough complex was renovated and a theatre was added to the "Arts" building. The boiler plant serving both schools is located in a building adjacent to the complex. Each school section is equipped with independently functioning mechanical ventilation systems. For this reason, each school will be described in separate reports. The focus of this report is the section of the complex occupied by the "City" Magnet School. The "Arts" Magnet School will be the subject of a separate report.

The section occupied by the City school consists of general classrooms, art room, library, specialty rooms and office space. The Arts and City schools share a common theatre and gymnasium; the gymnasium also functions as the kitchen/cafeteria. Windows in the school are openable.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The school houses grades K-8 with a student population of approximately 350 and a staff of approximately 80. The tests were taken under normal operating conditions. Test results appear in Tables 1-4.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million of air (ppm) in sixteen of twenty-four areas surveyed, indicating a ventilation problem in a number of areas of the school. Of note was classroom 215, which had a carbon dioxide level over 2,000 ppm indicating little or no air movement. It is also important to note that a large number of classrooms had open windows during the assessment, which can greatly contribute to reduced carbon dioxide levels.

Ventilation is provided by a single AHU located in a penthouse on the roof of the school (see Picture 1). Fresh air is distributed via ductwork connected to wall-mounted air diffusers in classrooms (see Picture 2). The amount of fresh air drawn into the unit is controlled by moveable louvers connected to an activator motor that adjusts to alter fresh air intake. Exhaust ventilation is provided by wall-mounted grates that return air back to the AHU via ductwork. This system was operating during the assessment.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the system must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was performed in February of 1989 (Certified Engineering, 1989).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings ranged from 66° F to 73° F, which were below the BEHA recommended range in the basement classroom areas. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ° F to 78 ° F in order to provide for the comfort of building occupants. Temperature control complaints were expressed to BEHA staff in a number of areas, which may indicate problems with thermostatic control and/or heat distribution. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the building was below the BEHA recommended comfort range in all areas sampled. Relative humidity measurements ranged from 22 to 34 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Standing water was noted in a number of areas on the roof (see Picture 3). The collection of water and its subsequent freezing and thawing during winter months can lead to roof leaks resulting in water penetration into the interior of the building. Pooling water can also become stagnant, which can lead to mold and bacterial growth, resulting in unpleasant odors and providing a breeding ground for mosquitoes in warmer months. Water damaged ceiling tiles were observed in a number of areas (see Picture 4). Room

213 contained a ceiling tile with possible mold growth. Water-damaged ceiling tiles can provide a source of mold and mildew and should be replaced after a water leak is discovered.

Plants were observed in a few areas. Plant soil and drip pans can serve as source of mold growth. Plants should be properly maintained and be equipped with drip pans. Plants should also be located away from the air stream of mechanical ventilation to prevent aerosolization of dirt, pollen or mold.

In a number of classrooms, spaces between the sink countertop and backsplash were noted (see Picture 5). A leaking faucet was noted in the health suite. Repeated leakage or improper drainage/overflow can lead to water penetration of countertop wood, the cabinet interior and behind cabinets. Like other porous materials, if these materials become wet repeatedly it can provide a medium for mold growth.

Other Concerns

Several other conditions were noted during the assessment, which can affect indoor air quality. Some classrooms contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be irritating to the eyes, nose and throat.

The main office and teachers' lounges have photocopiers. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). School personnel should ensure that local exhaust ventilation is activated while equipment is in use to help reduce excess heat and odors in these areas.

AHUs are normally equipped with filters that strain particulates from airflow. The filters provide filtration of respirable dusts. In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency can be installed. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent (Minimum Efficiency Reporting Value equal to 9) would be sufficient to reduce many airborne particulates (Thornburg, D., 2000; MEHRC, 1997; ASHRAE, 1992). Note that increasing filtration can reduce airflow (called pressure drop) which can reduce the efficiency of the AHU due to increased resistance. Prior to any increase of filtration, the AHU should be evaluated by a ventilation engineer to ascertain whether it can maintain function with more efficient filters.

BEHA staff examined the interior of the AHU and noted filters coated with dirt/dust and accumulated material. This condition obstructs airflow through the filters, and may serve to reaerosolize and distribute pollutants to occupied areas via the ventilation system. In addition, the configuration of pipes around the AHU filter rack obstructs the opening of the filter rack access panel (see Picture 6). To gain access to filters the hinges securing the filter rack access panel must be loosened to remove the panel.

Several inactive bee hives/wasps nest were noted in the science museum, which reportedly serve as learning tools (see Picture 7). Insect parts can become dried out and aerosolized and may serve as a source of allergenic material for certain sensitive individuals. Several areas had missing/or dislodged ceiling tiles (see Picture 8). The movement of ceiling tiles can introduce dirt, dust and particulate matter into occupied areas of the school. Accumulated chalk dust was noted in several classrooms. Chalk dust is a fine particulate, which can be easily aerosolized and is an eye and respiratory irritant.

The building was reported to have a history of rodent infestation. Bait traps were noted in cabinets beneath sinks in several areas. Under current Massachusetts law that will go into effect November 1, 2001, the principles of integrated pest management (IPM) must be used to remove pests in state buildings (Mass Act, 2000). A copy of the IPM guide is attached as Appendix A.

School officials reported a reoccurring problem with exhaust entrainment from the boiler plant located adjacent to the school. Although no odors of exhaust emissions or measurable levels of carbon monoxide were noted indoors by BEHA staff on the day of the assessment, the possibility of entrainment does exist. The boilers release emissions from a series of vent pipes approximately 10-15' below the plant roof (see Picture 9). Certain wind and weather conditions can result in the entrainment of these exhaust emissions into open windows or air intakes of the adjacent school building (see Picture 1), which may, in turn, provide opportunities for exposure to products of combustion such as carbon monoxide. Boiler exhaust and wind conditions should be closely monitored to avoid the entrainment of emissions inside the building via open doors, windows and/or AHU fresh air intakes.

A number of classrooms contained cleaning products under sinks and on counter tops. Classroom 117 had flammable materials and a spray can of insecticide under the sink (see Picture 10). Insecticides, cleaning products and other flammable materials contain VOCs, which can cause eye, throat and respiratory irritation. In addition, applicators of pesticides should be in full compliance with federal and state rules and regulations that govern pesticide use, including posting and notification requirements (333 CMR 13.10). Under no circumstances should pest controlling products be applied by untrained personnel. Such products should not be applied prior to or during school hours. If application must be done during the school week, they should be applied shortly after the school day ends, in order to give the applied areas ample time to dry. Flammable materials found in classrooms should be stored in a storage cabinet that meets design criteria set forth by the National Fire Protection Association (NFPA, 1996).

The teacher's room contained an unsecured helium tank standing against the refrigerator (see Picture 11). Cylinders of compressed gas should be fixed to a wall or stand to prevent damage to the cylinder valves by tipping. A damaged cylinder valve can cause an immediate and uncontrolled release of the cylinder contents and may result in the cylinder becoming a projectile.

Conclusions/Recommendations

In view of the findings at the time of our inspection, the following recommendations are made:

1. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control. Consider having the systems balanced by a professional HVAC engineer. Have the engineer examine fresh air intakes for proper function and increase the percentage of fresh air intake if necessary.
2. Repair and/or replace thermostats as necessary to maintain control of comfort.
3. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in

conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

4. Repair any water leaks and replace any remaining water-stained ceiling tiles. Examine the areas above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.
5. Ensure plants have drip pans. Examine drip pans for mold growth and disinfect areas with an appropriate antimicrobial where necessary.
6. Seal areas around sinks to prevent water-damage to the interior of cabinets and adjacent wallboard. Inspect wallboard for water-damage and mold/mildew growth, repair/replace as necessary. Disinfect areas of microbial growth with an appropriate antimicrobial as needed.
7. Acquire current Material Safety Data Sheets for all products that contain hazardous materials and are used within the building, including office supplies, in conformance with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL. 1983).
8. Secure gas cylinders to prevent accidental discharge.
9. Store chemicals and cleaning products properly and out of the reach of students.
10. Store flammable materials in flameproof cabinets consistent with local and state fire codes.
11. Change filters for HVAC equipment as per the manufacturer’s instructions, or more frequently if needed. Clean and vacuum interior of units prior to operation to avoid the re-aerosolization of accumulated dirt, dust and debris.
12. Consider increasing the dust-spot efficiency of HVAC filters. Note that increased filtration can reduce airflow produced through increased resistance. Prior to any

increase of filtration, the AHU should be evaluated by a ventilation engineer to determine whether it can maintain function with more efficient filters.

13. Ensure exhaust ventilation is operating during photocopying to help remove excess heat and odors.

14. Keep wasps' nest away from ventilation equipment and open windows to prevent the aerosolization of potentially allergenic materials. Consider bringing in items on an "as needed" basis.

15. Clean chalkboards and chalktrays regularly to prevent the build-up of excessive chalk dust.

16. Close classroom windows and doors adjacent to the boiler plant during wind/weather conditions conducive for the entrainment of exhaust odors. Consider extension of the boiler exhaust vent pipes if problem persists.

17. It is highly recommended that the principles of integrated pest management (IPM) be used to rid this building of pests. A copy of the Massachusetts IPM recommendations are included with this report as Appendix A (MDFA, 1996). Activities that can be used to eliminate pest infestation may include the following:

    - Rinse out recycled food containers. Seal recycled containers with a tight fitting lid to prevent insect access.
    - Remove non-food items that insects may be consuming.
    - Store foods in tight fitting containers.
    - Avoid eating in classrooms. In areas were food is consumed, periodic vacuuming to remove crumbs is recommended.
    - Regularly clean crumbs and other food residues from toasters, toaster ovens, microwave ovens, coffeepots and other food preparation equipment.

- Examine each room and the exterior walls of the building for means of egress and seal. If doors do not seal at the bottom, install a weather strip as a barrier to pests.
- Reduce harborages (cardboard boxes) where insects may reside.

References

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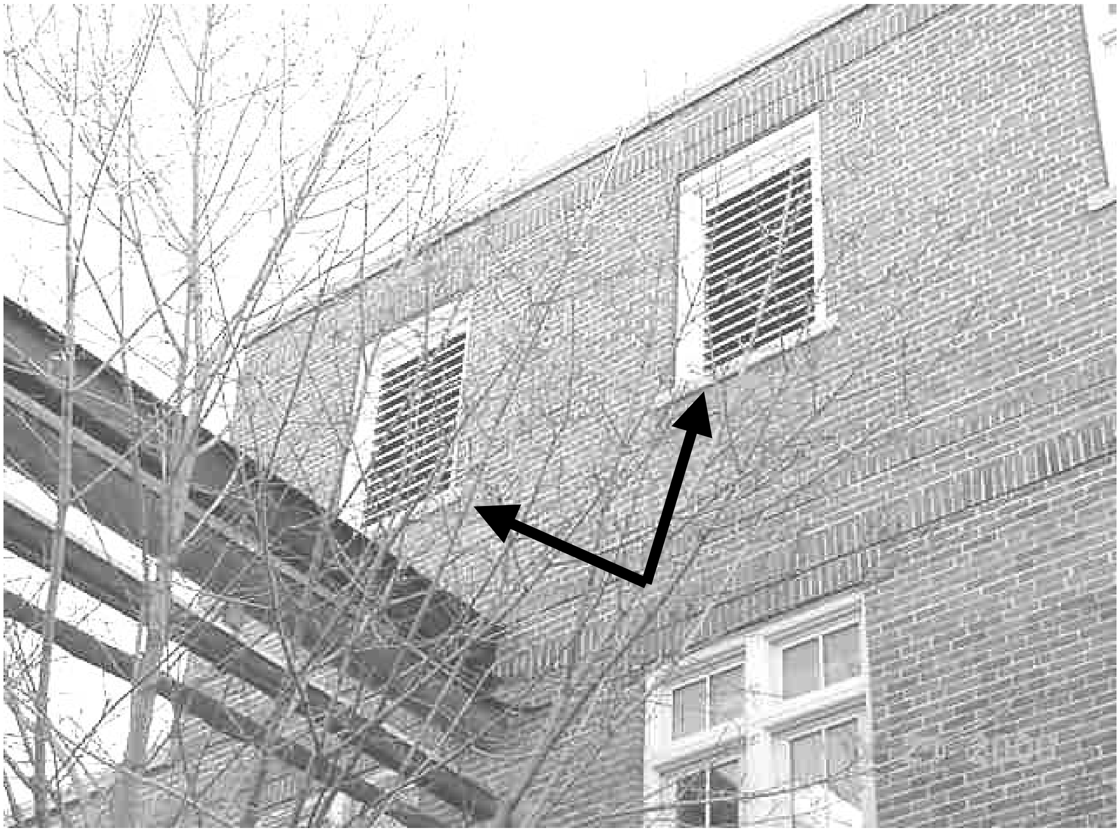
Picture 1



Fresh Air Intakes for HVAC Penthouse on Roof of City Magnet School

Picture 2

Wall-Mounted Fresh Air Diffuser

Picture 3

Water Pooling on Roof

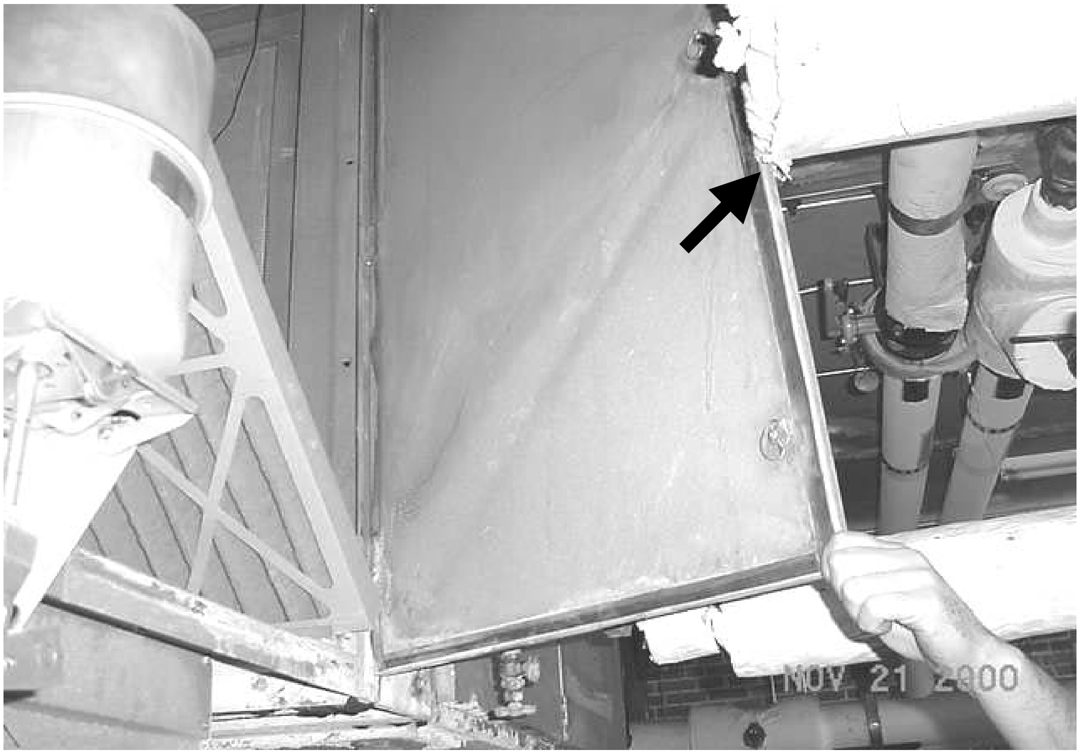
Picture 4

Water Damaged Ceiling Tiles

Picture 5

**Spaces between Backsplash and Sink Countertop,
Also Note Space between Backsplash and Wallboard**

Picture 6



Filter Bank Access Panel Obstructed by Pipe

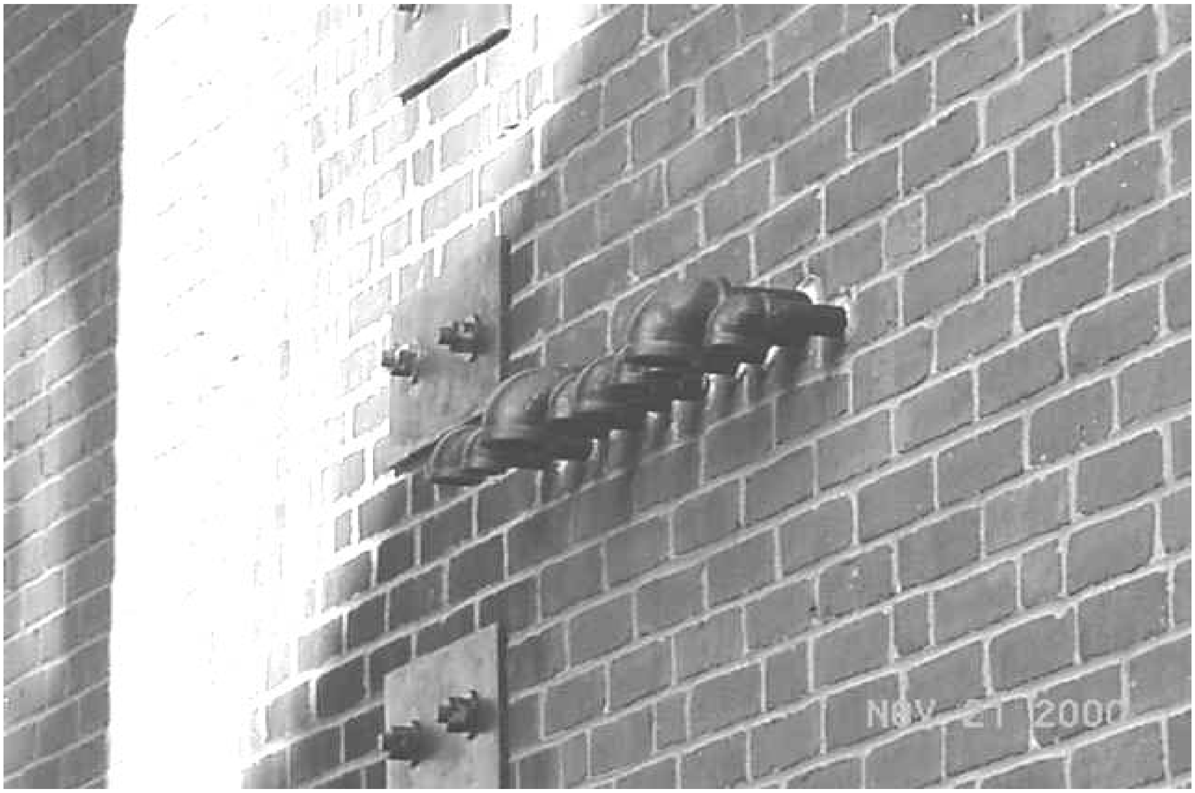
Picture 7

Inactive Bee Hives & Wasps/Hornets Nests in Science Museum

Picture 8

Missing Ceiling Tile

Picture 9



Boiler Plant Vent Pipes

Picture 10

Cleaning Products and Flammables under Sink in Classroom

Picture 11

Unsecured Helium Cylinder in Teachers' Lounge

TABLE 1

Indoor Air Test Results – City Magnet School, Lowell, MA – November 21, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	352	50	24					CO=0
207	789	73	26	5	Yes	Yes	Yes	Chalk dust, CO=0
208	747	73	24	4	No	Yes	Yes	Cracked CT, 2 CT ajar, chalk dust
203	722	73	23	10	Yes	Yes	Yes	Spaces around sink/backsplash, 4 elec. Stoves, refrigerators, laundry room-elec. dryer with exhaust, storage room-exhaust
203-Main frame Closet		72						Missing CT, temperature complaints-heat
202	909	73	23	1	Yes	Yes	Yes	30 computers, dry erase board, temperature complaints-heat, CO=0
201 – Art Room	1219	73	25	21	Yes	Yes	Yes	Spaces around sink/backsplash, CO=0
213	680	71	22	0	Yes	Yes	Yes	Spaces around sink/backsplash, 7 water damaged CT-1 with possible mold growth, carpet, CO=0

*** ppm = parts per million parts of air**
CT = ceiling tiles
CO = carbon monoxide

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – City Magnet School, Lowell, MA – November 21, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
215	2105	73	30	26	Yes	Yes	Yes	Spaces between sink/backsplash, primer/sealer on counter, carpet, CO=0
103	1367	73	28	22	Yes	Yes	Yes	Spaces between sink/backsplash, reports of mice
104	1201	73	26	22	Yes	Yes	Yes	Door open, spray cleaners on/under sink, CO=0
105	1044	73	25	0	Yes	Yes	Yes	Occupants gone ~5 mins., cleaning product under sink, CO=0
Outside/Background North Side-Exterior Wall								CO=2, Taken on French Street during moderate traffic conditions
Science Museum	928	66	34	20	No	Yes	Yes	Terrarium filled with inactive bees/wasps nests, water damaged/separated backsplash
Market Place	737	68	28	6	Yes	Yes	Yes	
Bank	784	69	28	2	No	Yes	Yes	
Cafeteria/Gym	1117	70	30	~200	Yes	Yes	Yes	

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TABLE 3

Indoor Air Test Results – City Magnet School, Lowell, MA – November 21, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
211	1268	72	28	25	Yes	Yes	Yes	
Library	729	72	23	1	Yes	Yes	Yes	Window open, 11 water damaged CT, 4 missing CT, CO=0
113	863	73	25	5	Yes	Yes	No	3 photocopiers, CO=0
Teachers' Room	782	72	24	1	Yes	Yes	Yes	Refrigerator, soda vending machine, coffee odors, helium tank
114	1161	73	25	25	Yes	Yes	Yes	Chalk dust, spaces between sink/backsplash-boxes under sink
115	1202	73	26	23	Yes	Yes	Yes	Accumulated items, spaces between sink/backsplash,
117	1457	73	27	23	Yes	Yes	Yes	Lamination machine, spaces between sink/backsplash, cleaning products/flammables/insecticides under sink, rubber cement, CO=0
116	1594	75	31	22	Yes	Yes	Yes	Spaces between sink/backsplash
101	1434	73	26	26	Yes	Yes	Yes	Accumulated items, door open

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Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – City Magnet School, Lowell, MA – November 21, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
102	850	72	23	24	Yes	Yes	Yes	Window and door open
212	940	71	26	26	Yes	Yes	Yes	Door open, CO=0
213	1097	73	27	25	Yes	Yes	Yes	
214	1370	73	28	21	Yes	Yes	Yes	CO=0
106-Principal's Office	814	71	24	1	Yes	Yes	Yes	CO=0
Main Office Area	859	73	23	3	No	Yes	Yes	Photocopier, CO=0
109	801	73	23	1	Yes	Yes	Yes	Personal fan, door open, CO=0
112	779	73	23	2	No	Yes	Yes	
108	837	73	23	0	No	Yes	Yes	Door open

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